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ABSTRACT

The purpose of this research bulletin is to provide educational decision-makers with empirical data for making informed decisions relative to the integration of technology in schools. Ten expanded abstracts of research studies are included here, each with a background/problem statement, list of study goals, description of methodology, conclusion statement, recommendations, and list of references. The titles of the abstracts are: (1) "Cooperative Learning in Computer-Based Instruction"; (2) "The Effectiveness of the Computer Simulation When Used as a Follow-Up Activity as Compared to Traditional Classroom Follow-Up Activities"; (3) "The Use of Applications Software in Schools: Paint System Image Development Processes as a Model for Situated Learning"; (4) "Computers and Classroom Change: The Teachers' Challenge"; (5) "The Effects of Using a Computer Authoring System on the Quality of Literature Assignments"; (6) "A Research-Based Writing Program for Students with High Access to Computers"; (7) "Helping At-Risk Children Through Distance Tutoring"; (8) "What Happens After ACOT: Outcomes for Program Graduates One Year Later"; (9) "The Evaluation of K-12 Instructional Software: An Analysis of Leading Microcomputer-Based Programs"; and (10) "Effects of Three Sorts of Revisions on Students' Comprehension of History Text." A list of additional resources on research in educational technology and specifications for researchers who may wish to submit abstracts conclude this bulletin. (DB)

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Research Bulletin #3

June 1990

Technology As an Instructional Tool: What We Are Learning

IR014750

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The purpose of the research bulletin *Technology as an Instructional Tool: What We Are Learning* is to provide educational decision-makers with empirical data for making informed decisions relative to the integration of technology. It is designed to make research results available in a timely fashion and in an easy-to-read format. The research bulletin describes the results of studies conducted by the MECC/University of Minnesota Center for the Study of Educational Technology. It also describes other technology-related studies not conducted by the Center that might be of interest to decision-makers.

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Foreword

The Center for the Study of Educational Technology is a unique partnership between MECC and the University of Minnesota College of Education. This partnership merges the practical experience and field-based success of MECC with the research expertise of the University. Founded in 1987, the Center was designed to improve the use of technology in schools. This goal is met by the Center's own research program by distributing information on research results of the Center and other institutions and by testing new models of field-based research.

Technology has been used in schools for many years but little empirically based research judging its effectiveness has accumulated. Dr. Peggy Roblyer of Florida A & M University bluntly states: "The overwhelming conclusion that you must come to is that there is not enough [technology-related] research to make good conclusions" ("World Leaders," 1988, p. 24). This lack of empirical evidence contributes to the growing apprehension about the value of continuing or expanding support for technology-related programs.

The Center's main focus is on conducting research to help build the empirical base related to technology use in the schools. By conducting its own research program and supporting the research of University faculty members, the Center is making contributions to this body of knowledge. However, the development of a research foundation alone will not help educators and the public decide on the appropriate use of technology.

To be useful, research results must be made available to decision-makers in a timely fashion and in a format that is easy to read. Center research results are published in scholarly journals, and the Center distributes two of its own publications: *The Research Synopsis* and *The Research Bulletin*. *The Research Synopsis* is a brief summary of current research results. *The Research Bulletin* is a detailed technical description of Center studies. Both publications are designed to present Center research and research efforts of other institutions in a format that is useful to educational practitioners.

Another Center focus is on the testing of new models for conducting field-based research. These models are an attempt to address the methodological shortcomings noted by researchers such as Dr. Henry Becker of Johns Hopkins University (Becker, 1987). Shortcomings include selecting student samples for the convenience of school class groupings instead of through a randomizing method, small sample sizes of typically fifty or fewer students, treatments of only a few weeks, and the lack of comparison groups to contrast to the technology-using students.

Finally, researchers and school administrators must work together to find creative solutions to the lack of school participation in technology-related research projects. The Center can facilitate discussions that address the following issues: (1) additional time and effort required by participating teachers, (2) scheduling the experimental treatment to coincide with an appropriate period in the school's curriculum, and (3) limiting unexpected school scheduling changes that can disrupt research plans. Building a solid technology-related research base requires cooperative efforts to remove the traditional difficulties associated with field-based research.

The MECC/University of Minnesota Center encourages educators engaged in research on educational technology to share their findings and make known to the Center the kinds of information they have available for distribution.

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EFFECTIVE TEACHING STRATEGIES FOR USING TECHNOLOGY

MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-1

Cooperative Learning in Computer-Based Instruction

by
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Background/Problem Statement

Cooperative learning in educational settings has been researched extensively since the 1920s. A 1981 analysis of 122 studies (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981) indicated three main benefits from cooperation. These were:

- Cooperation is more effective than competition and individualistic work.
- Cooperation with intergroup competition is better than competition and individualistic efforts.
- No significant difference is found when comparing interpersonal competitive and individualistic efforts.

A major recommendation from the study was: "Given the general dissatisfaction with the level of competence achieved by students in the public school system, educators may wish to considerably increase the use of cooperative learning procedures to promote higher student achievement" (p. 58).

Today, individualized instruction is the most common education usage of computers. In fact, most commercial software is structured for individual work, and research indicates that computers can be used effectively in this manner. The individualized use of computers has caused certain members of the educational community to become concerned about whether this type of computer use inhibits students in the development of social and communicative skills. While computer activities are not commonly structured as cooperative experiences, researchers studying the uses of computers in education have commented about the increased social interaction observed around the computer. Instead of leading to social isolation, the computer appears to generate group activity (Simpson, 1986).

Study Goals

The purposes of this study were: 1) to evaluate thirteen recent studies that examined the effects of merging the cooperative learning structure with computer-based instruction (CBI), and 2) to identify guidelines to help teachers structure the integration of cooperative learning and CBI. The study methodologies can provide education practitioners with useful guidelines on how to accomplish the integration of cooperative learning and CBI.

Methodology

The research projects reviewed involved students from grade 3 through college, with content ranging from mathematics to Hebrew. Most students were randomly grouped for the research, with some stratification for sex, age, and/or ability. Topics addressed include the areas of achievement, ability levels, patterns of study, social interchange, motivation, attitudes, and gender comparisons.

Conclusions

A general observation of all studies reviewed was that cooperation at the computer can produce positive results.

Studies assessing achievement levels showed that cooperative CBI results in either higher achievement or in no significant differences. Results showed that working cooperatively can affect the way students do their work (e.g., the types of choices they make in the study process) and how students relate to one another. Group work allows students to observe, imitate, and learn from one another. They keep themselves on task and share the sense of accomplishment. The encouragement, support, and approval of their peers can build motivation and make learning an enjoyable experience. Not only can the experience be positive for students, but it also provides an efficient means for accommodating large groups of students with a limited number of computers.

The studies indicate that a key element to success is the structure of the environment, which must be established and monitored in such a way as to ensure that learning takes place. Also, individual accountability and interdependence must both be developed. Some research has shown that participation patterns are more equal for males and females than in other settings.

While the majority of CBI has been designed for individual use, teachers are developing strategies and techniques to allow students to work together effectively while using that software. Various cooperative CBI implementation strategies have been suggested, such as using a word processing program to teach written language skills (Brown, 1989; Johnson & Johnson, 1986) or using simulations such as *The Oregon Trail* or *The Market Place* in a group setting (Isenberg, 1989). When designing cooperative CBI strategies, teachers must deal with issues such as the size of the groups, equity concerns, and software that is designed for cooperative use. The table on the following page summarizes researchers' recommendations for addressing various implementation issues (Dickson & Vereen, 1985; Johnson & Johnson, 1985, 1986).

Cooperative Learning in CBI: Implementation Guidelines

- Find software that supports group work.
- Decide on the size of the groups.
- Set goals and structure the activities (Johnson & Johnson, 1985, p. 2):
  1. Work in groups of two to four.
  2. Rotate roles.
  3. Make sure everyone agrees before information is entered into the computer.
  4. Ask other group members for help when needed.
  5. Summarize and explain to partner(s) what you are learning.
  6. At the end of the lesson, briefly discuss how well you worked together and make recommendations for improving next time.
- Teach collaborative skills.
- Promote equity.
- Provide rewards.

Recommendations

Simply grouping students to work on a CBI activity does not ensure that what has been termed "cooperative learning" automatically occurs. Providing students with a certain amount of structure increases the likelihood that the students will work together in a way that contributes to their learning. Following the guidelines described in the table above can help teachers maximize the positive effects of cooperative CBI.

While current research has identified many positive results from cooperative CBI, additional research is needed to answer questions such as:

- How should students be grouped to optimize learning?
- Can the use of cooperative CBI help eliminate sex-related differences in achievement?
- Do certain software design features facilitate cooperative CBI?

New research should help practitioners to select software programs and develop implementation strategies for cooperative CBI.

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MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-2

The Effectiveness of Computer Simulation as a Follow-Up Activity Compared to Traditional Classroom Follow-Up Activities

by
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Background/Problem Statement

In recent years the potential of technology to improve education has been recognized by several task forces, including the National Commission on Excellence in Education (1983) and the National Task Force on Educational Technology (1986). Reports from these task forces also stressed the importance of helping students develop higher-order thinking skills.

Computer simulation is a technological application that has the potential to help students develop higher-order thinking skills. A computer simulation is a representation of a real-life situation, but with less detail. Simulations are designed to allow students to be actively involved in making decisions and dealing with the consequences of those decisions. This process aids in the development of higher-order thinking skills (Lunetta and Peters, 1985).

Previous research on computer simulations showed that large-group presentation of simulations may be slightly more beneficial than small-group presentations, although no major differences in students' ability to recall concepts were found (Sherwood & Hasselbring, 1985/86). A recommendation of the Sherwood-Hasselbring study was that additional research compare the effect of computer-based instruction to more traditional class methods before drawing any definitive conclusions. The study described in this article compared the effectiveness of computer and non-computer teaching strategies at the elementary level because little research had been done at that level.

Study Goals

This study followed the Sherwood-Hasselbring recommendation. Three research questions were explored in this study:

1) Is the teaching strategy of lecture, discussion, and computer simulation as a follow-up activity more effective than computer simulation used as stand-alone instruction?

2) Is computer simulation, used as a follow-up activity to lecture and discussion, more effective than the traditional follow-up activities of role-playing and cooperative learning?

3) Is the traditional classroom teaching strategy of lecture, discussion, and follow-up activities more effective than computer simulation used as a stand-alone instruction?

Methodology

The study involved 66 fifth-grade students from three different classes in a suburban elementary school. Each class was randomly assigned to one of the following treatments:

- a traditional classroom presentation (lecture/discussion) followed by traditional follow-up activities (role-playing and cooperative learning)
- a traditional classroom presentation (lecture/discussion) followed by a computer simulation as a follow-up activity
- the computer simulation as stand-alone instruction

The computer-based simulation/game "Fire!" (Johnston, 1987) was used in the study. "Fire!" is a simulation of forest-fire fighting. Students make decisions on how and when to control a forest fire by using bulldozers, chemicals, or backfires. The object is to keep the cost of controlling the fire as low as possible while saving the greatest number of acres.

The same post-test was given to each class immediately following instruction, and two weeks later the test was repeated.

Conclusions

The results of this study showed no significant difference in student achievement between the computer treatment group and the non-computer treatment group. This study yielded three major conclusions:

- Computer simulation used alone is not as effective as a traditional classroom presentation.
- Computer simulation used alone is not as effective as using traditional classroom presentation followed by the simulation.
- There is no significant difference between using computer simulation or a traditional follow-up activity.

Recommendations

Although this study did not show that computer simulation improved post-test results, simulation may contribute to the educational process in other ways, such as improving teacher effectiveness. By using a computer simulation to occupy some students, the teacher is available to assist other students who need one-on-one instruction. Also, because the computer can handle record-keeping, teachers are able to spend less time on scoring and documentation, leaving more actual instruction time. Thus, while the computer simulation was not shown to increase student achievement directly, it may increase teacher effectiveness and affect student achievement indirectly.

Educators have the option of using either computer simulations or traditional activities as follow-up to instruction. The two methods were shown to be equally effective.

The study also found that computer simulation used as a stand-alone method of instruction is significantly less effective than the other methods. It seems fair to conclude that teachers should avoid substituting simulation for traditional classroom presentations. Simulation is more effective when used as a follow-up activity.

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MECC/University of Minnesota Center
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Project No. 90-3

The Use of Applications Software in Schools: Paint System Image Development Processes as a Model for Situated Learning

by
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Background/Problem Statement

In the last several years, increased criticism of "traditional educational software" has appeared in research literature. This criticism presents three main arguments:

- Technology directs rather than supports education (Sloan, 1980).
- Student interaction with computers is not necessarily neutral (Bowers, 1988).
- Drill-and-practice, tutorials, simulations, and programming software inhibit students from engaging in true problem-solving (Streibel, 1986).

Hawkins and Sheingold (1986) state that teachers frustrated with the educational possibilities of programming and traditional courseware are experimenting with computer applications programs (tools). Tool software is open-ended, promoting an education that includes the expressive forms of learning and provides greater opportunities for problem solving. This is in contrast to traditional software that the authors believe encourages the prescribed intentionality of linear procedural processes.

In the past several years computer "paint" (drawing) programs have increased in sophistication. Paint tools, like word processing programs for writing, provide new instructional opportunities in art education. First, paint tools provide students with a mode of interaction that promotes a problem-*posing* perspective as opposed to the problem-*solving* approach of simulation software. Second, paint tools allow students to develop an image by using a process called seriation (Freedman, 1989) whereby students create an image, modify it, and still have access to the original version. The ability for students to easily elaborate and refine imagery through seriation can facilitate the learning of aesthetics (Gaitskell, Hurwqitz & Day, 1982).

Study Goals

This research was conducted to find out whether the use of a paint program in an art education course can promote a problem-posing approach to learning, and, if this is true, to identify how this actually occurs within the learning environment. Specifically, this study was designed to answer four main questions concerning student learning with a paint program:

1. Which of the following characteristics will students focus on during image development: technical, manipulative, formal, cognitive, or effective?
2. Will the students develop images in ways similar to their methods in other art media?
3. To what extent will the capabilities of the software (such as the available graphics functions) direct image development?
4. Will interactions between students influence image production?

Methodology

Eleven university undergraduates enrolled in a "computer graphics in art education" course participated in the study. Each student produced at least two sets of seriated images on an Apple IIGS computer by using *Deluxe Paint II* software. Seriation itself was used to record the process of image development.

A thematic case-study approach framed the research procedures. While each student was considered a "case" and studied individually, themes derived from the research questions were analyzed across participants. To facilitate triangulation (cross-validation), a variety of documentation procedures were used (Fielding and Fielding, 1988; Patten, 1988; Mathison, 1988; Miles and Huberman, 1988). These included 1) structured interviews, 2) journals/sketchbooks, 3) surveys/questionnaires, and 4) photographic and tape recorded records of the students' images and work processes.

Conclusions

When using new computer functions or approaches, students tended to be more technical and manipulative during image development. As the study progressed and students became more familiar with the technology, a shift occurred. Image development became more formal and conceptual.

At the beginning, students assumed that they would use the software in ways similar to traditional painting. Most of the students started the course by drawing sketches of images they wanted to produce, just as they would with other art media. Before the course ended, all of the students abandoned the manual sketching in favor of using the computer as a sketchbook. After they gained experience on the computer, students began to use the strengths of the software rather than trying to get the computer to simulate the strengths of other media.

Available graphics functions did influence image development for some students. For the most part, this entailed an adaptation on the part of the students to utilize the drawing strengths of the program. For example, one student, who usually draws humans, switched to geometric forms and color fields because of the functions of the software. Other students, when unable to draw what they intended on the screen, found that experimentation often resulted in unexpected yet interesting results.

Students found interactions with other students to be beneficial to image production. In addition to being influenced by the comments of others, students incorporated the effects created by other students into their own work.

Recommendations

The results of this study show that the educational use of computers can be broadened to include application software as an alternative to traditional courseware. It further suggests a new model for courseware: a less structured instructional approach in which students are able to both pose and solve problems.

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MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-4

Computers and Classroom Change: The Teachers' Challenge

by
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Background/Problem Statement

> *"Those who acquire it will cease to exercise their memory and become forgetful; they will rely on (it) to bring things to their remembrance by external signs instead of their own internal resources."*

This sounds like a criticism of today's inundation of technology and its potential impact on society and education. The critic, however, was Plato, arguing against the introduction of writing in Greece (*Power On*, 1988).

Changes in the methods of education are generally viewed with skepticism. Nevertheless, education has been called on to change no fewer than three times in the last four decades: during the sputnik-inspired science era of the 1950s, the "return to the basics" theme of the late '60s and '70s, and Holmes', Carnegie's, and others' call for "excellence in education" of the 1980s.

Technology is expected to play an important part in society. If national polls can be believed, computers will play a major role in the improvement of education. This leaves a significant question unanswered: How will technology, which is viewed synonymously with change, be integrated into an educational system that is historically resistant to change?

Study Goal

What is technology's role in developing a better-quality student? Just as important, what is the instructional role of the teacher as computer technology is introduced into the classroom and curriculum?

Reviewing the long-term initiatives and trends in education may give some perspective on these issues. This paper examines some of the changes that technology has brought to the educational system, hypothesizes on where educational technology will be in the future, and provides suggestions for instructors to facilitate classroom change.

Conclusions

Technology was a significant issue of the 1980s. It was touted by vendors, media, legislators, and some educators as an essential and easy-to-use key to educational excellence. The problems of implementation, however, were predictable:

- limited student access to computers (Becker, 1985, 1987);
- limited teacher interest in having computers in their classrooms (Norris & Lumsden, 1984); and
- few strong indicators describing the effectiveness of using instructional computing.

High expectations and personal successes were the story of the day. Evidence of the effectiveness of teaching with and having students use computers was based on numerous success stories and anecdotes. Becker (1988) characterizes the research by saying, "The existing evidence of computer effectiveness is very scanty . . . however, we are in a position to say computers are better than just iffy."

The Office of Technology Assessment (OTA), a research arm of the United States Congress, completed in 1988 a major study on technology in the public school system. They found that while "the results build an incomplete and somewhat impressionistic picture, they do suggest that certain configurations of hardware and software, used with particular populations of children, and under the supervision of competent teachers, contribute to meeting specific instructional objectives" (OTA, 1988).

For the first time in a national report, OTA reported that technology cannot be fully effective unless teachers are offered the choice using computers and unless those who choose to use them receive training and support. In addition, the report indicated that one of the areas most significantly affected by computer use was classroom teaching style. The report concluded that there was no one best use of technology or best way of teaching with technology.

Administrators and legislators wanted fast results—results in terms of fewer dropouts and higher SAT scores. When these were not forthcoming, dollars for computers became scarce in the mid-1980s and were redirected to other programs to improve education. In the rush for a quick fix, effective teacher instruction as the critical element in the successful classroom use of computers was overlooked. The system failed to offer sufficient flexibility to integrate computers into the mainstream environment (Cohen, 1988), and educational computing was relegated to the background as another overrated educational revolution.

Recommendations

The research is clear on one point. "The process by which teachers appropriate technology is more complex than that by which teachers adopt other changes" (OTA, 1988). Integration of computers into the curriculum takes time. The basis for any time frame of integration is poorly established, but for any given teacher a two- or three-year period would not be unusual.

Instructional computing presents significant opportunities for teachers and students to take a challenging new path. Computers can facilitate:

- interactive learning, whereby students become participants, not passive viewers;
- individualization and alternative learning approaches;
- amplification of everyday experiences and provisions for increased student exploration (Bork, 1980); and
- access to new information sources, local and remote, and increased opportunities for analyzing information.

The elements of good teaching and an environment open to change facilitate the effective use of computers. In the right environment, computers offer instructors with an opportunity for professional renewal through use of a dynamic and powerful way to teach. While technology may not be compelling enough to drive the educational system to change, it does offer individual teachers and their students the opportunity to grow.

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MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-5

The Effects of Using a Computer Authoring System on the Quality of Literature Assignments

by
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Background/Problem Statement

Traditional literature assignments require students to write about literature with little or no teacher direction. Guided literature assignments, which are based on a sequence of response strategies (Beach, 1987), result in significantly higher levels of interpretation (Appleman, 1986; Reilly, Beach & Crabtree, 1986). In order to plan effective literature assignments, it is important for teachers to be familiar with these response strategies as well as with activities designed to involve students with those strategies.

Using a computer authoring system (Macintosh HyperCard), Beach (1989) has developed a program to help teachers create guided literature assignments. The program provides teachers with a systematic approach for considering a range of contingencies related to the development of guided assignments: response strategies, response activities, instructions to students, and use of demonstration models.

Study Goals

This study examined the following questions:

1. What is the effect of employing an authoring system versus no authoring system on the quality of guided assignments produced by secondary teachers enrolled in a secondary literature methods course?
2. What are teachers' attitudes regarding the value and usefulness of the authoring system?

Methodology

Twenty-eight teachers enrolled in a graduate level literature methods course taught in spring 1989 at the University of Minnesota were randomly assigned to one of two groups: one that used the authoring system to develop guided response literature assignments and one that used a traditional, non-computer method. Both groups received training in basic methods for developing guided response literature assignments.

After completing their assignments, teachers in both groups rated the perceived degree of difficulty and complexity involved in completing the assignments. Teachers in the

authoring-system group also indicated the degree to which the system was or was not helpful in developing the assignments. They also specified those aspects of the software that were or were not helpful.

These assignments were then independently rated by two judges, according to the following criteria: 1) range strategies and activities, 2) logical sequencing, 3) overall coherence, 4) appeal of activities, and 5) overall quality.

Conclusions

No significant differences were found between the groups on any of the criteria or in mean ratings for the perceived difficulty or complexity involved in completing the assignments. It may therefore be concluded that using the software did not improve the quality of the teachers' assignments.

All of the teachers who used the software rated it as helpful. It was consistently helpful in selecting strategies, selecting activities, and providing models. Some teachers found that the software was not helpful in sequencing activities and/or providing directions.

Recommendations

The lack of significant differences between the groups should be qualified by the influence of two factors. Training received by all of the teachers prior to their assignments, as well as their prior teaching experience, may have influenced the quality of the assignments. Further research needs to take into account these and other factors.

Although using the authoring system did not improve the quality of their assignments, the fact that that group responded positively to the software suggests that it may have the potential to enhance teachers' interest and attitudes towards developing guided literature activities. Further research, consisting of recording what the subjects say they are thinking while completing the task and/or interviewing the subjects, needs to examine subjects' specific responses to the software, particularly in terms of determining its influence on the decision-making process.

In order to be more helpful to teachers, further software development beyond the program created by Beach is recommended to give teachers the ability to revise their plans. Specifically, the ability for teachers to revise the generic directions to include specific information about a particular assignment is suggested.

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Apple Classrooms of Tomorrow
Advanced Technology Group
Apple Computer, Inc.

ACOT Report No. 2

A Research-Based Writing Program for Students Who Have High Access to Computers

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Background/Problem Statement

Of all the areas of the curriculum, writing is the one in which computers seem to earn most rapid endorsement from teachers. Many claims have been made as to the advantages of writing with a computer. Many educators who incorporate word processing into their students' writing programs agree that computers make revising and editing much easier, and that once children are comfortable with keyboarding they write more than they do when using paper and pencil. Research that evaluates the anecdotal evidence is necessary to help determine the future direction of word processing in the curriculum.

In ACOT classrooms, students routinely use computers to draft, revise, proofread, and print their writing assignments. Teachers report that with daily use of computers, students do more revising at the structural as well as the mechanical level. Teachers also note that their students are not only better writers, but they are more confident, motivated, and willing to collaborate than ever before.

Based on the premise that word processing makes revising and editing easier, a computer-intensive writing program was developed as part of a research effort from January through June 1987 at the Cupertino, California, ACOT site. This program focused on helping students improve in four major aspects of writing: fluency, knowledge of text structures, writing processes, and sharing.

Study Goal

Achieving the objectives of the program is essential to students' writing success, with or without computers. The purpose of this study was to measure and evaluate how the computer-intensive writing program contributed to the students' success.

Methodology

Data collection included both qualitative and quantitative approaches. The primary methods included observation in the classroom and collection of work samples. The data included extensive field notes taken during classroom observations and videotapes that documented some of the writing activities. In addition, teachers evaluated sets of ACOT and non-ACOT compositions by providing both comments and numerical ratings.

Conclusions

The most significant factor in learning to write is the quality of instruction, not merely access to computers. Evaluations of written work in both the ACOT and non-ACOT classes indicated that focused instruction and conscientious revision promote effective writing.

During the writing assignment session, teachers noted that access to computers is likely to enhance students' willingness to write and revise more. Children maintained a high level of enthusiasm, comfort, and persistence seldom seen when they plan, draft, and revise their writing with paper and pencil.

Computers helped students make their compositions much more presentable, which encouraged sharing. Writers were much more willing to share their work when they had legible, computer-produced text.

Students wrote more and better when they had high access to computers. ACOT students did almost twice as much writing as students in other classes during the same time period. In addition, ACOT stories had more complicated plots and included more dialogue. This trend was especially prevalent in comparing the writing of ACOT and non-ACOT low-achieving students.

Third-grade ACOT students learned to keyboard an average of 26 words per minute. This enabled them to record thoughts much faster than they could by hand. Nevertheless, their proficiency in handwriting remained comparable to their peers.

Recommendations

While the objectives of a computer-intensive writing program are similar to those in any high-quality writing program, the learning can be facilitated to a far greater degree when children have high access to computers than when they use paper and pencil or have limited access to computers.

The research highlights the importance of effective instruction. Teachers need to model all stages of the writing process and assist students in completing each stage.

It is evident that students' writing and their approaches to writing change when they write with computers regularly. However, a closer analysis of what those changes are is critical in order for educators to determine how best to implement technology in the teaching of writing.

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ACOT Report No. 4

Helping At-Risk Children Through Distance Tutoring

by
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Background/Problem Statement

If money and resources were no object, which instructional orientation would be the most effective for promoting student learning in schools?

There is no easy answer, but a clear contender would undoubtedly be one-on-one tutoring with each child working with his or her own teacher. Unfortunately, achieving student-teacher ratios of even 20:1 is impossible for most schools, given the practical constraints of limited budgets, teacher shortages, and lack of classroom space. Even when there are qualified volunteers to work with children after school, arranging mutually convenient times and places to meet can be difficult.

An alternative one-on-one instructional approach, using distance tutoring through an electronic Bulletin Board System (BBS) accessed by modem, was developed for the Memphis Apple Classroom of Tomorrow (ACOT). The project, which paired university students with academically at-risk sixth grade ACOT students, was a collaboration between Apple Computer, Inc., the Memphis City Schools, and Memphis State University.

Study Goal

The study set out to evaluate the first year of the BBS tutoring program, to determine how the program would affect students' performance on the California Achievement Test, and to plan for improvements in the second year of the program.

Methodology

Ten tutors from the Master of Arts in Teaching program at Memphis State University were each assigned two or three students from the sixth-grade ACOT class. All of the student participants were minority students from an economically disadvantaged and academically at-risk population. At the beginning of the school year, several orientation and training

sessions for students, peers, and tutors were conducted on the computer equipment and the Bulletin Board System.

Tutoring assignments monitored during the study consisted primarily of activities designed to develop writing skills. For example, students would send pieces of writing to their tutor for critiquing before submitting a final version to their classroom teacher. Or the tutor would send a document containing errors, and the students would attempt to identify the mistakes. In addition to formal assignments, tutors and students were encouraged to use the BBS to share everyday experiences and to keep in regular contact with each other.

BBS messages were monitored, tabulated, and coded during intermittent observation periods. Tutors kept daily logs of their activities and completed an end-of-year survey. Student outcomes, measured by the California Achievement Test, were compared with control classes. Attitudes toward school and education by both students and parents were also measured.

Conclusions

Usage of the BBS was very high, averaging close to 200 messages per week. Tutors, students, and ACOT staff accounted for approximately equal proportions of the total. Girls used the BBS much more frequently than boys, especially for social messages, which accounted for 48 percent of the total. Academic messages, the next most frequent type, accounted for 15 percent. Other communication categories were tutor activities, thesis activities, announcements, exercises/explanations, grade reports, and technical assistance requests and replies.

In general, tutors found the activities and experience rewarding. Specifically, they felt that their positions as role models and mentors were important in setting positive examples for the children and in motivating them toward achievement. That the tutoring process took place entirely through written communication was further perceived to be a strong advantage in helping improve reading and writing skills.

The logistics posed some frustrations for participants. Because it operated on a single phone line, the BBS was frequently busy and callers had to call back repeatedly to connect. The system design precluded real-time interchange of messages and feedback. Tutors also felt pressure by time restrictions (30 minutes) and space allotted for writing messages. Furthermore, some tutors noted the absence of a systematic curriculum plan for integrating tutoring with classroom learning activities.

Evaluations of student outcomes showed some advantages for ACOT students over control groups on the California Achievement Test subtests of math computation, math concepts/applications, and language mechanics. Attitudes toward school and education were more positive for ACOT students and parents.

Recommendations

Experiences during the initial year clearly demonstrated the potential for using this form of distance tutoring to help at-risk children learn and gain self-confidence. It is important to note that the technology was able to bridge the physical and cultural distance between two diverse groups of participants—college-educated tutors and partly-educated students. The success of this program has led to a refined and expanded program in the second year at Memphis ACOT.

Based on the experiences of the first year, the BBS used in the second year of the program is more powerful and flexible, allowing for virturally unlimited caller access and capabilities for real-time interaction between tutors and students. Also, the BBS now enables students to "meet" other AppleLink users from all over the country, "attend" forums on computer topics, and access numerous information sources.

Tutoring assignments will be more carefully planned to achieve a better fit with the curriculum and the distance learning environment. Efforts will be increased to involve parents and arrange more face-to-face contacts between students and tutors.

The results of this study, while encouraging, must be viewed cautiously since there were many extraneous factors involved. Further research will examine whether advantages persist and, if so, will attempt to isolate the important contributing factors.

Although this distance tutoring program may not completely remove the risks of academic failure these children face, it can accomplish much in cutting those risks.

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EVALUATION OF SCHOOL TECHNOLOGY PROGRAMS

Apple Classrooms of Tomorrow
Advanced Technology Group
Apple Computer, Inc.

ACOT Report No. 5

What Happens After ACOT: Outcomes for Program Graduates One Year Later

by
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Background/Problem Statement

Since the technology-intensive ACOT (Apple Classrooms of Tomorrow) program was initiated four years ago, participating teachers and parents have observed dramatic changes in ACOT students' academic achievements, self-esteem, motivation, and willingness to take on new challenges. Although research findings regarding ACOT's immediate effectiveness have been generally positive (Kitabchi, 1987; Ross, Smith, Morrison & Erickson, 1988; Fisher, 1988; Tierney, 1988; Baker & Herman, 1989), little is known about how long and to what extent such benefits endure.

Some research suggests that a positive carryover is hampered by the lack of cognitive stimulation in the economically disadvantaged home to reinforce what is learned in school (Heyns, 1978). Furthermore, unless children can be helped to develop the skills needed to learn from experiences, exposure to enriched environments may do little good (Bransford, 1979).

In view of these interpretations, two distinctive properties of the ACOT program seem to increase the likelihood of long-lasting effects. One is the parents' strong interest in the ACOT program, which prompts them to encourage their children's learning and provide better home environments. A second is the children's acquisition of new knowledge and attitudes through daily use of computers. Consequently, key variables of the post-ACOT experience are the degree of continued parental involvement and the number of opportunities that students have to apply their computer skills to new learning activities. These properties are incorporated into the research design of this study.

Study Goal

The goal of this study was to answer the following research questions:

- Do former ACOT students demonstrate any advantages relative to control students in basic skills, motivation, classroom socialization, and computer skills?

- How do computer access and computer activities in the conventional classroom compare to access and activities in the ACOT setting?
- What are the parental attitudes concerning their children's experiences in the conventional classes as compared to the ACOT environment?
- Do students maintain the same levels of performance and motivation during the post-ACOT school year?

Methodology

The research sample included 24 out of 25 students who were sixth-graders in the Memphis ACOT program the previous year (1987-1988). The control group consisted of 29 randomly selected students who were enrolled in two non-ACOT sixth-grade classes at the same time and at the same school as the ACOT sample. ACOT students and control students lived in the same neighborhood and were considered to be comparable in general abilities, motivation, and home environment. Both groups were regarded as reasonably representative of the overall population of sixth-graders at the target school.

The research design includes assessment of the ACOT and control groups in student attitudes (fall and spring); parent attitudes (spring); teacher evaluations (fall and spring); academic achievement in reading and math (fall and spring); and keyboarding skills (fall and spring).

The research team collected data on post-ACOT student attitudes in two ways: by administering a survey designed to assess general attitudes toward school and learning, and by conducting interviews to prompt students to discuss the previous year's school experiences compared to the current year. Likewise, the team administered a survey to assess parents' attitudes toward the role of computers in society and for learning, and conducted interviews concerning their children's school experiences during the ACOT and post-ACOT school years. Seventh-grade English, math, and computer teachers conducted a survey that evaluated the ACOT and control students' performance and motivation. Academic achievement in reading and math was measured by obtaining students' California Achievement Test scores from school records. Keyboarding skills were measured with the MECC *Keyboarding Master* program.

Conclusions

Overall, the ACOT students were indistinguishable from their peers on the basis of school accomplishments. Once they were placed back in a traditional environment, the ACOT students were once again educationally at-risk, despite their accomplishments in the innovative program. Some of the specific results found are listed below.

- Both the ACOT and control groups had extensive computer use during the previous year, and both expressed negative feelings of loss in a nearly computer-less environment.
- ACOT and control group parents agreed that computers are important to society and to children's learning. ACOT parents further indicated that computer experiences motivated their children and involved them in positive learning activities that would otherwise have been unavailable.
- English teachers rated ACOT students slightly higher than control students in the fall, but spring ratings showed no significant difference. Within the

ACOT group, the ratings indicated a significant decline in self-confidence from fall to spring. Math teachers gave both ACOT and control students rather poor ratings over the year. Math and English teachers indicated that both groups of students had problems with motivation and behavior, and that they had the ability to perform at much higher levels than they actually did.

- The computer teacher's ratings showed that ACOT students were unprepared for her highly structured course, which covered programming in BASIC, word processing, and computer functions. Her approach was dramatically different from the ACOT approach to computing, which focused on using computers as tools for learning and performing particular tasks. In a follow-up interview, however, the teacher rated the ACOT students as above average in keyboarding and basic familiarity with computers, and as superior in willingness to take on new challenges with computers.
- The ACOT students received higher standardized test scores than control students in both math and English. Results showed the ACOT group to be superior on all measures; their advantages in mathematics were highly significant and their advantages in reading approached statistical significance.
- ACOT students' keyboarding skills averaged 39 words per minute in the fall compared to the control group's 18 words per minute. This superiority of the ACOT group over the control group was evident again in the spring.

Possible reasons for the ACOT students' reverting to former academic and social behaviors include the short duration of the innovative program; a return to a teacher-directed, rote learning environment; and the unavailability of computer tools to support learning.

Memphis ACOT students have demonstrated that by being able to work with computers they can increase the range of their accomplishments while developing skills with modern technology applications valued by society. As they acquire and demonstrate those skills they can feel positive about themselves. But to remain so empowered, students must have continued access to the tools on which those successful performances depend.

Recommendations

Based on the above conclusions, the research team makes the following recommendations to increase the transferability of the ACOT experiences to learning in conventional classrooms.

- Improve communication between teachers. Where computer-intensive education is presented in the previous year, and students will have limited access to computers the next year, provision needs to be made for the transition.
- Provide continued computer access. Through computer-intensive experiences, children are likely to become highly skilled at using computers for learning. The retention of this skill strongly depends on the availability of computers after the children leave the program.
- Extend the program length. It seems unreasonable to expect only one or two years of working in a computer-intensive environment to result in significant changes (Slavin & Madden, 1989). With extended program

experiences, starting in earlier grades and continuing for longer periods, the likelihood of noticeable program impacts should greatly increase.

- Increase parental involvement. Parents are a key element in helping at-risk students to succeed in school (Slavin & Madden, 1989). Therefore, greater effort needs to be made to increase the involvement of parents throughout the school year.

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THE DESIGN AND USE OF TECHNOLOGY-RELATED PRODUCTS

MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-6

The Evolution of K-12 Instructional Software: An Analysis of Leading Microcomputer-Based Programs

by
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Background/Problem Statement

In the last half of the 1970s, microcomputers became available at prices that made it possible to bring them into public school classrooms. At first, little instructional software was available, and teachers were forced to write their own or adapt business software to classroom use. This situation, however, was short-lived.

Microcomputer hardware quickly evolved from slow and linear cassette tape technology to advanced high-speed and large-memory disk drives and processing capabilities. These advancements challenged and enabled instructional software designers to develop increasingly sophisticated programs. The changes had tremendous impact on key features of instructional programming, such as user interface, on-line support, display fonts, color, animation, and sound.

This study was undertaken to chronicle and analyze the developmental trends of leading educational software programs from 1980 to 1988.

Study Goal

The goal of this study was to develop a history of the early years of software evolution by identifying and analyzing leading K-12 instructional programs. It is hoped that such analysis will help both consumers (teachers and administrators) and producers of computer-based instructional programs to speculate about and meet the needs of the future.

The findings of this study are descriptive in nature. They provide insight into how instructional software looked at various phases of its recent evolution. This information is of value to educational technology historians, students of educational technology, software developers, and others as they reflect on the role of computers as instructional tools.

Methodology

Instructional software specialists representing elementary and secondary schools, teacher education, and the software industry were asked to identify the leading publishers of K-12 instructional software. For this study, the definition of a leading publisher was one that produces instructional software for the K-12 market on a broad range of subjects. Four such companies were identified: The Learning Company, MECC (Minnesota Educational Computing Corporation), Scholastic Software, and Sunburst Communications.

Each company selected instructional products in two categories from each year they had been in business. The categories were Most Popular (defined as the program with the highest sales) and Most Technically Advanced (defined as the instructional package of which the company is the proudest). The lists were then examined to determine whether the products possessed the attributes of instructional software. Tool software, collections, and multiple listings were eliminated.

Each program was then reviewed to classify the software on 36 attributes in six categories:

Descriptive
- Name of software
- Publisher and date of publication
- Intended audience
- Content area
- Type (drill-and-practice, simulation, or educational game)

Hardware
- Memory requirements
- Alternative input options (mouse, joystick, etc.)
- Printer requirement

Display
- Upper and/or lowercase letters
- Column width
- Fonts
- Animation
- Color
- Sound
- Voice
- Pull-down menus
- Dialog boxes

Instructional Characteristics
- Program control (linear or by menu selections)
- Different levels of difficulty
- Program branching based on student performance
- Design similarities to familiar software
- Use of examples
- Motivational feedback
- Informational feedback

Student Options
- Online tutorial
- Help screens
- Student-controlled levels of difficulty
- "Save" options
- Ease of entering and exiting from program
- Quick reference card
- Off-line activities

Teacher Options
- Track student performance
- Teacher-controlled options
- Technical support (documentation or Help Line)
- Lesson plans/objectives

Conclusions

In both the Most Popular and Most Technically Advanced categories, most of the products are for math, science, and problem-solving and are targeted for students in grades K-5. A majority of the software is classified as games or simulations.

Not surprisingly, older software requires less memory than newer software. Almost half of the products in each of the two categories make use of alternative input devices such as a joystick or mouse. Until 1984, printing options were not associated with instructional software; of those that use printing now, most are writing instruction programs.

There is little variation in the column width used in screen displays; most use 40 characters per line. All but one program have both upper- and lower-case displays. Animation and color are common attributes of instructional software across the period of study. Speech and pull-down menus first appeared in 1986 in the Technically Most Advanced category. Windows and dialogue boxes became regular features after 1982.

Over half of the programs reviewed have multiple levels of difficulty, but only a few adapt instruction according to student performance. Motivational and informational feedback appear in software across the entire period studied, with motivational feedback appearing more often in Most Popular programs.

There is no consistent pattern regarding attributes manipulated by students, such as help screens, exit options, and off-line support. Management systems and teacher options started to appear in 1986 in Technically Most Advanced and later in Most Popular programs.

Recommendations

The overriding trend is that instructional software will continue to increase in size and complexity. Features that directly affect this, such as color, animation, student management, speech, and printing options are popular attributes of recent instructional programs. This will result in software publishers investing more time and money into product development. Consequently, consumers should expect software of the future to cost more, require more sophisticated systems, and satisfy more complex instructional needs.

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MECC/University of Minnesota Center
for the Study of Educational Technology

Project No. 90-7

Effects of Three Sorts of Revisions on Students' Comprehension of History Text

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Background/Problem Statement

This was the first of two studies investigating text difficulty. In this study, we investigated ways to improve comprehension of history texts. Reports from such agencies as the American Federation of Teachers (Gagnon, 1987), the Council of Basic Education (Tyson-Bernstein, 1988), the Educational Excellence Network (Sewall, 1987), and the National Endowment for the Humanities (Cheny, 1987), as well as those from teachers and parents, indicate that many textbooks are poorly written and do little to foster students' learning and understanding and even less to develop students' interest in the topics presented. In the second study, we will investigate ways to improve students' comprehension of software manuals.

In a recent study (Graves et al., 1988), our research group asked linguists, composition instructors, and *Time-Life* writers to revise history texts. Analysis of the revisions indicated that the linguists and the composition instructors made structural changes to improve the coherence of the passages, while the *Time-Life* writers made changes intended to make the passages more interesting, vivid, and personal. Field trials of the revised texts showed that the *Time-Life* revisions resulted in huge increases in recall, while those of the other writers resulted in modest increases or none at all.

Two recent attempts to replicate these findings have been unsuccessful (Britton, van Dusen, Gulgoz, & Glynn, in press; Duffy, et al., 1989). Both studies produced results indicating that the composition instructors' revisions were better recalled. Results of this study are contributing to our work on users' comprehension of software manuals.

Study Goal

The purpose of the present study was to gather additional data on the same four sets of passages, which were used in all previous studies. Specifically, our goal was to better

understand whether interesting and vivid writing or coherent and succinct writing is more likely to improve comprehension, recall, and student attitudes toward the texts.

Methodology

Study participants were 200 eleventh-grade students from a suburban high school in a lower- to middle-class suburb of Minneapolis.

Materials for the study included four versions of two 400-word passages from a high school history text (an original version, a *Time-Life* revision, a composition instructors' revision, and a linguists' revision), lists of the ideas presented in each passage, six short-answer questions for each passage, and an eight-item attitude survey.

The study required two days to complete. On the first day, students read one of the eight versions and then wrote a recall of the passage. On the second day, without rereading the passage, students wrote a second recall of it, took the short-answer test, and completed the attitude survey.

Conclusions

Students had better written recall and could answer more short-answer questions on the versions written by composition instructors. Although attitudes toward the four versions did not differ greatly, students consistently preferred the composition instructors' versions.

In general, the texts revised by the composition instructors were found to be more coherent, more straightforward, and relatively brief. They were better recalled, better comprehended, and somewhat better liked than the other texts. This included the versions by the *Time-Life* writers, whose goal was to make the text more interesting, vivid, and personal.

Recommendations

The results of this study and the parallel results from Britton and Duffy and their colleagues leads to the recommendation for editors, authors, and those who select texts for students to write and select texts that are coherent and relatively brief, perhaps at the expense of being interesting and vivid.

At the same time, the results of all these studies are based on the same two 400-word passages. This is too limited to generalize to the world of textbooks or the larger world of what students should read. So, while it seems logical to use texts that are coherent and straightforward, it also seems prudent to search for ways to make these texts more interesting and vivid.

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ADDITIONAL RESOURCES ON RESEARCH IN EDUCATIONAL TECHNOLGY

Additional Resources on Research in Educational Technology

In addition to reporting on research, the MECC/UM Center publications identify other resources of interest to educators. These resources are selected for their comprehensive coverage of research trends and their timeliness of publication.

- Office of Technology Assessment, U.S. Congress. 1989. *Linking for Learning: A New Course for Education.* Washington, D.C.: U.S. Government Printing Office.

  A free summary is available from the Office of Technology Assessment, (202) 224-8996, Document Number SET-439. The full report is available from the Superintendent of Documents, (202) 783-3238, Document Number GPO 052-003-01170-1 at a cost of $9.00 plus shipping and handling.

- *Computer Survey Newsletters.* Center for Social Organization of Schools, The Johns Hopkins University. 3505 North Charles Street, Baltimore, MD 21218

Technical reports related to ongoing research are also available from the following research centers:

- Apple Classrooms of Tomorrow (ACOT)
  Apple Computer, Inc.
  20525 Mariani Avenue, M/S 42C
  Cupertino, CA 95014
  (408) 974-5219, contact Connie Troy

- Bank Street College of Education
  Center for Children and Technology
  610 West 112th Street
  New York, NY 10025
  (212) 663-7200

- Educational Technology Center
  Harvard University
  337 Gutman Library
  Appian Way
  Cambridge, MA 02138

MANUSCRIPT SPECIFICATIONS

Manuscript Specifications

The MECC/University of Minnesota Center is interested in reporting the research results of educational practitioners and researchers from other institutions. Two copies of each manuscript should be submitted. Manuscripts should be typed double-spaced on one side of an 8-1/2 by 11-inch sheet of paper, with uniform margins. The author's name, professional title and affiliation, address, and telephone number should appear on a separate sheet of paper. Manuscripts should conform to the following guidelines.

Description

The manuscript should be viewed as an expanded abstract. It should include a background/problem statement, study goals, methodology, conclusions, and recommendations. A description of each section follows. The abstracts are published in the Center's research bulletin, *Improving the Use of Technology in Schools: What We Are Learning*. Currently, the bulletin is published once a year and is mailed to individuals who have requested specific information about Center activities. The bulletin has a diverse readership, including university faculty, staff development personnel, computer coordinators, and teachers. While the research bulletin is more technical than popular computing magazines, authors should write for a diverse audience with different levels of expertise with educational research. A good guideline when writing manuscripts is to view the research bulletin as intermediate between a non-technical article and a scholarly article.

Background/Problem Statement

This section describes and defines the question or problem and provides background information. This includes the importance or significance of the project, identification of audiences that may find project results useful, working definitions, and limitations of the study. Whenever possible, validate the problem definition with supporting citations.

Study Goals

This section briefly describes study goals or hypotheses.

Methodology

This section contains descriptions of the sample, research design, and measurements used. The population from which the sample was drawn and the method of selecting the sample should be detailed in the sample description. A short description of the educational environment in which the project took place is highly desirable. Details of the research design should include identification of the type of research design and review of the steps taken to collect data, including any that may have influenced the results.

Conclusions

This section briefly describes research results.

Recommendations

The emphases in this section should be on identifying and interpreting the major findings. Whenever possible, discuss why the results may have occurred, fit them into findings of previous research, suggest field applications, and make theoretical interpretations (Borg and Gall, 1983). The Center is especially interested in how research results affect the classroom use of technology.

References (instructions)

Follow the American Psychological Association (APA) format when you compile the reference section of the manuscript.

References (for this section)

Borg, W., & Gall, M. (1983). *Educational Research: An Introduction* (4th ed.). New York: Longman.

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